

COPEPODA OF NORTHERN MISSISSIPPI
WITH A DESCRIPTION OF A NEW SUBSPECIES

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ABSTRACT

Variable types of Mississippi surface waters north of 33° north latitude were examined qualitatively for the occurrence of calanoid and cyclopoid copepods. A total of 283 collections was made from 59 sites from August 1972 through July 1973. Samples were taken once each season. Twenty-five species in four families, including three which were represented by two subspecies, were taken in the study area. A new subspecies of *Diaptomus bogalensis* is described. *Diaptomus pallidus* and *Tropocyclops prasinus* and its subspecies *T. p. mexicanus* were the most numerous and widespread calanoid and cyclopoid copepods taken. Seventeen species are new records for Mississippi.

Despite their importance, the free-living, freshwater copepods have been given relatively little attention in the United States. In Mississippi, in particular, there is a lack of systematic work on this group. Marsh (1907, 1912, 1929) noted the presence in Mississippi of *Macrocyclus albidus*, *Eurytemora affinis*, *Diaptomus mississippiensis* and *D. pallidus*. Eddy & Simer (1928) also recorded *Cyclops bicuspidatus* and *Mesocyclops leuckarti* from Mississippi. Wilson & Yeatman (1959) specifically mention the presence in Mississippi of *D. virginensis*, and Grantham (1958) noted the presence of *Mesocyclops edax* and *D. mississippiensis*. One other rare calanoid, *Epischura fluviatilis*, was recently taken from Pickwick Reservoir on the Mississippi-Alabama border by D. L. Bunting (personal communication).

The current investigation surveys and updates the knowledge of the cyclopoid and calanoid copepods in surface waters of Mississippi north of 33° north latitude.

MATERIALS AND METHODS

Samples were taken with a 30.5 cm plankton net using number 25 silk bolting cloth. Collections were made at 59 sites once per season for a total of 283 collections (some sites collected in several locations). Samples were taken from 13 lakes, nine ponds, nine streams, 10 rivers, 10 ditches and other intermittent waters, and nine swamps, sloughs or small oxbow lakes. Six Mississippi river drainages were sampled: Tombigbee, Big Black, Pearl, Tennessee, Yazoo and Upper Mississippi including the Horn, Hatchie, and Wolf systems. The study area covered approximately 53,000 km² and 40 counties. Samples were taken from the surface to a depth of approximately 2.0 m or less depending upon the depth of the water, except that in the five large reservoirs, samples were taken to depths of approximately 5.0 m. Specimens were killed in 5% formalin and preserved in 70% ethanol. Dissected and whole specimens were mounted in glycerin jelly. Species identification and terminology follows that of Wilson & Yeatman (1959).

At each site dissolved oxygen content, temperature and pH measurements were taken using a YSI oxygen meter, model 51A and Coleman Metrion IV pH meter.

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RESULTS

Twenty-five species, three of which were represented by two subspecies, were taken in the study area. One undescribed species and a new subspecies, *Diaptomus bogalusensis marii*, were included in the collections. The order Calanoida was represented by three families: Centropagidae (one genus with one species), Temoridae (one genus with one species) and Diaptomidae (one genus with nine species). The order Cyclopoida was represented by only one family, the Cyclopidae, with six genera and 14 species.

Seven species, including *Diaptomus sanguineus*, *D. virginiensis*, *Osphranticum labronectum*, *Eurytemora affinis*, *Cyclops bicuspidatus thomasi*, *C. crassicaudis brachycercus* and *Macrocyclus ater* were taken only during the winter and/or early spring sampling period when temperatures were considerably lower and water levels were higher. Four species, *Diaptomus dorsalis*, *Macrocyclus fuscus*, *Mesocyclops tenuis* and *Eucyclops agilis montanus* were found only in the summer collections. All other species were present throughout the year with the exception of two species which appeared in three of four collections.

Oxygen levels ranged from a low concentration of 0.4 ppm to a high of more than 15.0 ppm without any evident effect on the number or diversity of copepod species. The same was true of the pH values for the various bodies of water which ranged from a low of pH 5.4 to a high of pH 9.7. Temperatures ranged from 19.5°C to 34.0°C in the summer, 0.0°C to 9.0°C in winter and 8.5°C to 23.5°C in the early spring.

LIST OF SPECIES

Order Calanoida

Family Centropagidae

1. *Osphranticum labronectum* Forbes, 1882

Family Temoridae

2. *Eurytemora affinis* (Pope), 1880

Family Diaptomidae

3. *Diaptomus dorsalis* Marsh, 1907
4. *D. siciloides* Lilljeborg, 1889

5. *D. sanguineus* Forbes, 1876
6. *D. virginiensis* Marsh, 1915
7. *D. pallidus* Herrick, 1897
8. *D. mississippiensis* Marsh, 1894
9. *D. reighardi* Marsh, 1895
10. *D. bogalusensis marii* new subspecies
11. *D. sp.*

Order Cyclopoida

Family Cyclopidae

12. *Paracyclops fimbriatus* (Fischer), 1853
13. *P. fimbriatus poppei* (Rehberg), 1880
14. *Eucyclops prionophorus* Kiefer, 1931
15. *E. speratus* (Lilljeborg), 1901
16. *E. agilis* (Koch), 1838
17. *E. agilis montanus* (Brady)
18. *Tropocyclops prasinus* (Fischer), 1860
19. *T. prasinus mexicanus* Kiefer, 1938
20. *Cyclops vernalis* Fischer, 1853
21. *C. bicuspidatus thomasi* Forbes, 1882
22. *C. crassicaudis brachycercus* Kiefer, 1929
23. *C. varicans rubellus* Lilljeborg, 1901
24. *Mesocyclops edax* (Forbes), 1891
25. *M. tenuis* (Marsh), 1909
26. *Macrocyclus fuscus* (Jurine), 1820
27. *M. albidus* (Jurine), 1820
28. *M. ater* (Herrick), 1882

ECOLOGICAL AND DISTRIBUTIONAL NOTES

Genus *Osphranticum* Forbes

Osphranticum labronectum was collected during the winter and early spring periods when water temperatures ranged from 2.5°C to 14.5°C. It occurred in shallow sloughs with little or no current, connected to or immediately adjacent to rivers and creeks. The species was taken from the Yazoo, Big Black and Pearl river drainages.

Genus *Eurytemora* Giesbrecht

Eurytemora affinis was collected during early spring in waters that ranged from

14.0°C to 16.5°C It was found in flooded oxbow lakes adjacent to and continuous with the Mississippi River.

Genus *Diptomus* Westwood

Diptomus dorsalis was found once in considerable numbers in the late summer collection. It was taken from a large creek with little or no current, in the Yazoo drainage.

D. sciloides was collected during all seasons, except late summer, in large lakes, streams and rivers of the Yazoo and Mississippi drainages.

D. sanguineus was found during the winter and early spring periods in the Yazoo and Pearl River drainages. It occurred in slow moving streams and sloughs and in a flooded field adjacent to a farm pond, but was not taken from the pond itself.

D. virginiensis was found in sloughs adjacent to rivers of the Yazoo drainage during the winter collection period. Water temperatures at the collection sites ranged from 3.5°C to 7.5°C.

D. pallidus occurred in all habitats sampled, and within a wide range of pH, temperature and dissolved oxygen values.

D. mississippiensis was collected during all seasons in the Yazoo, Tombigbee, Tennessee and Big Black river drainages. It was predominantly lentic, appearing most often in lakes and ponds, but was not taken from creeks.

D. reighardi was abundant and widespread and was found during all seasons in all drainages and in all types of habitats. Two-thirds of the collections of this species were made from lakes and ponds.

Description of New Subspecies

D. bogalusensis marii new subspecies (Figs. 1-6)

Occurrence: This species was taken from all drainages and during all seasons in northern Mississippi. It was found most often in lakes, ponds and other standing waters, but was collected on rare occasions from lotic habitats.

Type lot: Holotype female, USNM 151227, paratypes, male and female, USNM

151228 and 151229, from Tishomingo St. Pk. Lake, Tishomingo Co., Miss.

Diagnosis: Female. Average length of 15 preserved specimens 1.11 mm (0.93 mm-1.30 mm). Metasome (Fig. 1) with head rounded; greatest width at posterior portion of first metasomal segment and second metasomal segment; width about 37% of total length of metasome. Metasome tapering gradually, especially distal to metasomal segment 3. Metasomal segments 5 and 6 not separated dorsally, "wings" of segment 6 directed posteriorly with small sensillum on lateral posterior corners.

Urosome (Fig. 2) 3-segmented, approximately 35% of length of metasome. Genital segment asymmetrical to nearly symmetrical, left side rounded, symmetric, right side more flattened on posterior margin with sensillum located on anterior margin. Segment 2 shorter than segment 3, caudal rami equal to or slightly longer than segment 3. Inner margins of caudal rami bearing hairs.

Antennules reaching beyond distal ends of caudal rami setae, one seta on segments 11 and 13-19.

Maxillipeds (Fig. 3) with distal lobe of basal segment bearing three setae.

Leg 5 (Fig. 6) basipod 1 subglobular and about as long as wide. Basipod 2 subtriangular and slightly longer than wide with lateral seta on external margin reaching along outside margin. Basipods 1 and 2 — 1.05; exopod 1 — 1.00; and exopod 2 — 1.08 (proportional lengths). Exopod 2 base slightly more than one-third of length. Exopod 2 bearing no lateral seta. Exopod 3 represented by two lateral setae on proximal lateral margin of exopod 2. Length of setae variable, but outer usually at least twice length of inner. Endopod reaching beyond base of exopod 2 with distal end bearing numerous fine setae and two longer setae, outer longer and its length slightly greater than greatest width of endopod. Endopod ends in pointed protuberance.

Male. Average length of six preserved specimens 1.03 mm (0.9 mm — 1.11 mm).

Metasome similar to female.

Urosome symmetrical.

Left antennule as in female. Right anten-

nule (Fig. 4) with spines of segments 8 and 12 shorter than width of their respective segments; spine 12 shorter than 8. Spine of segment 10 nearly as long as width of segment and spine of segment 11 longer than width of segment 11. Spine on segment 13 almost reaching proximal margin of segment 15. Spinous process present on segments 15 and 16 with 15 the larger.

Leg 5 (Fig. 5) with right posterior face of basipod 2 bearing blunt, bifid spine on distal margin. Exopod 1, inner distal margin with small rounded lamella. Exopod 2 inflated anteriorly, spine about as long as width of segment at spine. Claw about as long as exopod, sickle-shaped, very robust.

Leg 5 left (Fig. 5) (excluding process) reaching to end of right exopod 1. Basipod longer and wider than exopod. Exopod segments 1 and 2 incompletely separated. Exopod 1 rounded inner pad and proximal pad of the second exopod segment with long hair. Exopod 2 with two prominent processes; the outer process stouter and longer than exopod. Inner, slender process about 80% of length of outer. Endopod very large and slightly longer and as wide as exopod. Distal end of endopod covered with many short, stout hairs.

Systematic position: This subspecies appears to be an intermediate form between *D. sinuatus* Kincaid, 1953 and *D. bogalusensis* Wilson & Moore, 1953, but more closely related to the latter. In the female this relationship is indicated by the nature of the genital segment of the urosome. The right side of this segment in *D. sinuatus* forms a small conical protuberance while in *D. bogalusensis* the right side is formed into a large laterally directed protuberance. This protuberance in *D. b. marii* is larger than in *D. sinuatus* but much more symmetrical and shorter than in *D. bogalusensis*. The fifth leg of *D. b. marii* differs from the other two species in that the spines representing the vestigial third exopod segment are unequal in length, the outer being much longer.

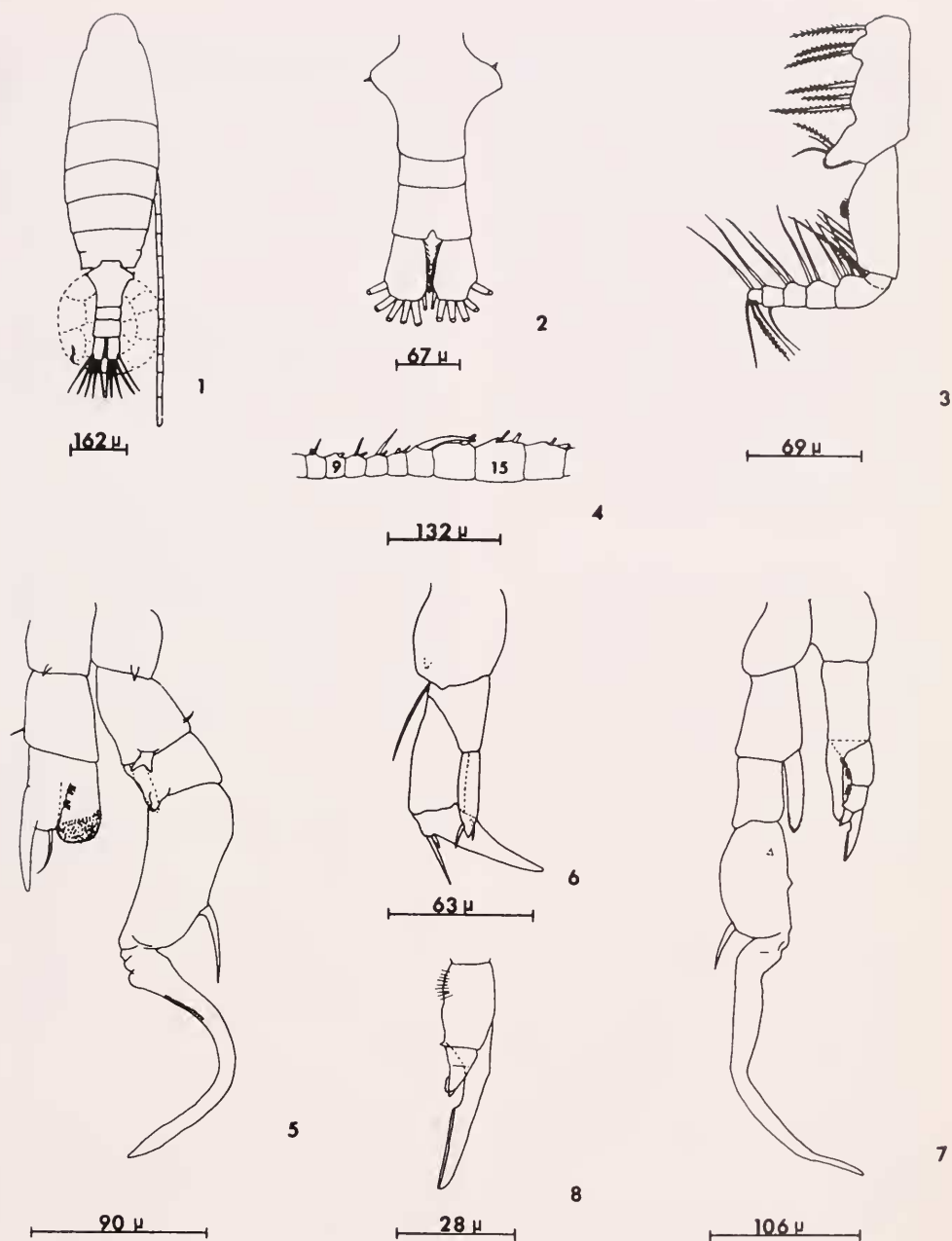
In the male the major areas of difference lie in the nature of the right antennule and the fifth legs. In *D. sinuatus* the spine on segment 13 of the right antennule reaches

the proximal margin of segment 15. In *D. b. marii* this spine almost reaches the proximal margin of segment 15 but in *D. bogalusensis* it reaches just beyond the middle of segment 14. The fifth leg of *D. b. marii* presents a number of similarities to *D. sinuatus* and *D. bogalusensis*. *D. b. marii* and *D. sinuatus* have a triangular lamella on the distal inner margin of right exopod 1. *D. b. marii* and *D. sinuatus* both have a small bifid spine on the distal margin of right basipod 2. The claw of *D. b. marii* is unlike that of the other two species in being sickle-shaped and robust. The left exopod 2 is quite similar in all three groups, with *D. b. marii* and *D. bogalusensis*, having a somewhat longer short spine than is present in *D. sinuatus*. Exopods 1 and 2 of the left leg are not completely separated in *D. b. marii* and *D. bogalusensis* while they are completely separated in *D. sinuatus*. The left endopod is similar in *D. b. marii* and *D. bogalusensis* but that in *D. sinuatus* is much longer and narrower. These three groups presently are found only in the southeastern United States: *D. bogalusensis* in Louisiana, *D. b. marii* in northern Mississippi and *D. sinuatus* in northwestern Florida. The morphological and geographical nature of *D. b. marii* indicates there may be a very close relationship between these three groups. With further collecting and a better understanding of their ranges, this relationship should be clarified.

Descriptive Notes on *Diaptomus* sp.

(Figs. 7, 8)

Male right first antennae without spinous process on segment 14 or 15. Exopod 2 of right fifth leg (Fig. 7) with outer margin rounded and inner margin with small stout spine. Claw of exopod 2 angled in two places and much longer than exopod. Endopod of right leg 5 enlarged as in *D. mississippiensis*. Left leg 5 terminal segment (Fig. 8) with two processes; outer more anterior process nearly as long as entire exopod with distal two-thirds of inner margin flattened. Inner and more posterior process triangular and less than one-half length of outer. Endopod reaching almost to distal end of short inner process. Average length of male 0.80 mm.



Figs. 1-8. *Diaptomus bogalusensis marii* new subspecies. 1. Female dorsal view. 2. Female urosome. 3. Female maxilliped. 4. Male right first antennae segments 8-16. 5. Male fifth leg posterior view. 6. Female fifth leg. *Diaptomus* sp. 7. Male fifth leg anterior view. 8. Male fifth leg detail of processes of left exopod two.

Occurrence: This copepod was found during all seasons and in all drainages except the Tombigbee. It was collected from all types of habitats with the exception of swamps and sloughs. More than 70% of the collections of this species were taken from lakes and ponds.

Remarks: According to H. C. Yeatman (personal communication), this species was being described by the late M. S. Wilson of Anchorage, Alaska. It has been collected by several other workers, from southeastern United States, including Dr. Yeatman and Dr. D. L. Bunting of the University of Tennessee at Knoxville. At this time and until Wilson's unpublished papers are studied, its status is uncertain.

Genus *Paracyclops* Claus

Paracyclops fimbriatus was found during all seasons in all types of habitats. It was present in all drainages except that of the Big Black and Pearl Rivers.

P. fimbriatus poppei was much less common than *P. fimbriatus*, appearing only during the winter and early spring collections in creeks, rivers, and intermittent waters of the Yazoo River drainage.

Genus *Eucyclops* Claus

Eucyclops prionophorus was collected only four times. It was found in late summer and early spring in the Yazoo and Tennessee River drainages. *E. prionophorus* was taken from one lake, two creeks and one pond.

E. speratus was found throughout the year in all types of habitats except rivers. It was present in the Yazoo and Tombigbee drainages.

E. agilis was present in all types of habitats and in all drainages throughout the year. It was one of the most common and widespread cyclopoid copepods encountered in northern Mississippi.

E. agilis montanus is much smaller and characterized by shorter caudal rami which are not more than 2.5 times their width. It was taken from swamps, sloughs and intermittent waters of the Yazoo River drainage.

Genus *Tropocyclops* Kiefer

Tropocyclops prasinus was widespread in all habitats and drainage systems. It was taken during the late summer, winter, and early spring periods.

T. prasinus mexicanus was found in all drainage systems, all types of habitats, and during all seasons.

Genus *Cyclops* Muller

Cyclops vernalis was taken from all drainages, at all seasons and from all types of habitats. It is quite variable, especially in the spination of the fourth swimming legs and the length of the spines of the fifth legs. Although collected during all seasons, *C. vernalis* was most abundant during the winter and early spring periods.

C. bicuspidatus thomasi was one of the most abundant cyclopoid species in the early winter and spring collections, but was not taken during the summer. It occurred in all drainages except the Tombigbee and in all types of habitats. Of the 27 collections made of this species, 17 were from lakes and ponds.

C. crassicaudis brachycercus was collected only in offshore plankton tows from two large impoundments in the Yazoo drainage.

C. varicans rubellus is a small, obscure species that was widespread but not common. It was taken from all habitats with the exception of ponds, and in all seasons. *C. v. rubellus* was found in all drainages except the area immediately adjacent to the Mississippi River.

Genus *Mesocyclops* Sars

Mesocyclops edax was present throughout the year and was widespread during the early spring collection. It was found in all habitats and all drainages with the exception of the Tennessee.

M. tenuis is a rare species that was taken once during the late summer of 1972 in a large oxbow lake between the levee and the Mississippi River in northwestern Mississippi.

Genus *Macrocyclops* Claus

Macrocyclops fuscus was found and identified only once from an immature form

collected during the late summer of 1972 in a small lake in the Tombigbee River drainage.

M. albidus was a common species widespread throughout the year in all habitats and all drainage systems except that of the Mississippi River proper.

M. ater is a widespread but uncommon form in the United States. It was collected once during the early spring in the Yazoo drainage in about 0.3 m of water in a flooded field adjacent to a farm pond, but was never taken from the pond itself.

DISCUSSION

During the course of the investigation, several significant range extensions were uncovered. *Eurytomora affinis* is a euryhaline species that is usually found in lakes and ponds of coastal areas (Wilson & Yeatman, 1959); however, during the current investigation specimens were recovered 1145 km upriver from the Gulf of Mexico well beyond any saltwater intrusion. Either this species has been missed in previous freshwater collections, or it is currently migrating into the inland freshwater environment. *Mesocyclops tenuis* is a rare species that has been collected primarily in the southwestern United States but was taken once during the summer of 1972 in northwestern Mississippi. *Cyclops crassicaudis brachycercus*, according to Bunting (1973), has previously been taken only from stagnant, temporary pools and wells and from littoral areas of shallow lakes. In northern Mississippi it was taken only in offshore plankton tows in two large man-made reservoirs. With more thorough collecting, many of these species with restricted ranges will undoubtedly prove to be more widely distributed than once thought.

A number of problems arose during this investigation concerning the interpretation of several species-subspecies complexes. Females of *Diaptomus pallidus* and *D. reighardi* posed one of the most difficult problems of the survey. The chief distinguishing characteristic between the two is the length of the two lateral setae of the terminal exopod segment of the fifth legs. In

D. reighardi the inner seta is longer and reaches beyond the middle of the claw, while in *D. pallidus*, the two setae are nearly equal in length and do not reach beyond the middle of the claw. A large number of individuals were encountered during this study that were transitional between the two species. Until a detailed investigation of the differences between them can be completed, identification of females of these species should be made with caution.

Another problem concerns the *Eucyclops agilis*-*E. speratus* relationship. From the material collected in northern Mississippi, there seems to be no easily recognizable distinction between them. Supposedly the main differences between the two are relative length of the caudal rami, length of the inner corner setae of the caudal rami and the prominence of the lateral spinules on the caudal rami. In the study area numerous individuals were found with characters intermediate between these species. Many individuals with the long caudal rami of *E. speratus* also had prominent lateral spinules of the caudal rami characteristic of *E. agilis*.

Tropocyclops prasinus and *T. p. mexicanus* presented another area of concern. Distribution notes by Wilson & Yeatman (1959) indicate that *T. prasinus* is the common form, but in northern Mississippi *T. p. mexicanus* is prevalent. Although, as expected, many individuals appeared intermediate between these two groups, the fact that *T. p. mexicanus*, *T. prasinus* and intermediates were taken from the same body of water at the same time indicates a need for reviewing the validity of this species/subspecies complex. Two other species were represented by two subspecies in the study area: *Eucyclops agilis* and *E. agilis montanus* and *Paracyclops fimbriatus* and *P. fimbriatus poppei*. Neither of these couples were collected from any body of water at the same time although they did occur in the same waters at different seasons. Further investigations of these subspecies is needed to determine if they are truly different or merely seasonal variations.

Of the calanoid copepods *D. pallidus* was the most common and widespread during all

seasons and the most common and widespread copepod collected during the summer period. *T. prasinus* and *T. p. mexicanus* were by far the most widely distributed cyclopoid copepods in the late summer, winter and early summer collections and were second only to *Eucyclops agilis* in the early spring collections. *T. p. mexicanus* was the most widespread copepod during the winter collection with *D. pallidus* being second.

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